# Trigger

DWARF meeting

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W. Lustermann, ETH Zurich

## Introduction

## Example CMS

## DWARF Trigger

# Introduction

## Trigger electronics

- In general electronics can do almost everything
- Typical questions are price and power consumption.
- Simple things are discriminators (also multiple with different
- thresholds), coincidences (timing, start-stop), sums and logical
- combinations of information (and, or, etc, ...)

## Costs

- Depends on the number of channels
- Number of discriminators
- Extra electronics, coincidences, timing units

## Power consumption

- Typical low for analog electronics
- depending strongly on the frequency for digital logic (FPGA)

I would try to keep room for later extensions of the system

# Trigger CMS ECAL

| | |
|---|---|
| Analog signal processing | • Pre-amplifier shaper ASIC with 3 different gain ranges for higher dynamic range (multi-gain-pre-apmlifier) |
| Data sampling and buffering | • Sampling of the shaped signal at 40 MHz using 4 channel, 40MHz, 12 bit ADCs (AD41240) ASICs<br>• Stored in digital pipeline ASICs (FENIX) with several extra functionalities |
| Data transmission | • Digital optical links (1 Gbyte / s), for data and trigger |
| Trigger primitives generation | • Linearization<br>• Summing of the energy in 25 crystals<br>• Calculation of the “fine grain bit”<br>• Bunch crossing identification |

# Trigger CMS

| | |
|---|---|
| CMS Tracker | • Uses analog pipeline ASICs (40 MHz) and analog optical links for data transmission |
| Calorimeter trigger | • The ECAL energy sums are combined with the HCAL energy sums<br>• The combined data are delivered to the global trigger |
| Global LV1 trigger | • Collects the trigger information of all sub-detectors<br>• Applies up to 128 different algorithms to the trigger data, producing 128 answer<br>• A logic combination of this 128 answers generates the level trigger signal<br>• Maximum rate: 100 kHz, multi event capabilities<br>• Latency 3 µs |
| Higher Level Trigger (HLT) | • Computer farm running reconstruction and analysis algorithms on the events data (highly parallel)<br>• Max. rate on disk 100 Hz |

# DWARF trigger

Use three levels of hardware trigger + if desired HLT (software)

**1 Coincidence definition**

- A digital trigger is not adapted for defining coincidence in the order of ns
- Constant fraction discriminator → very good timing properties (400 ps)
- Simpler: low threshold discriminators (1ns)

**2 pulse height selection**

- Based on energy sums and discriminators with higher thresholds, events fulfilling the coincidence condition are selected or rejected

**3 geometrical event selection (optional)**

- Use hit multiplicity from the coincidence definition and from the puls height selection and combine it with geometrical information
- FPGA (almost any speed a computer can run at) (potential of multiple algorithms)
- This could be an add-on which does not need to be available initially

**HLT**

- software

# DWARF trigger

Trigger rate, trigger efficiency for background rejection and dead time of the system must be matched:
A system with high bandwidth and low dead time (or multi event capabilities) can use a simple trigger, accepting a lot of background

**Coincidence definition**

- Individual coincidence conditions could be defined in rather small regions (next neighbors)
- Logical combination of different regions or
- Coincidence combination of coincidences

**Pulse width**

- I guess this might be rather difficult because of the long tail (30-40) ns of the MGPA pulse?

**Pulse height**

- non overlapping sums
- Multiplicity of regions
- Overall sum? (summing of many channels is critical, because of calibration mismatches)